

**Late Cretaceous knobby trigonians from the
Izumi Mountains, Southwest Japan***

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和泉山脈産の後期白亜紀三角貝

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和泉山脈の上部白亜系和泉層群（畦ノ谷層）から収集された大型三角貝（knobby trigonians）を調べ、2種を識別した。うち1つは新種である。これらの三角貝は、従来我が国で *Steinmanella* (*Yeharella*) として分類されてきた諸種と同様な形態を示すが、*Yeharella* KOBAYASHI and AMANO, 1955を *Yaadia* CRICKMAY, 1930と同義とする SAUL (1978) の見解を受け入れ、*Yaadia obsoleta* (KOBAYASHI and AMANO) および *Y. tanii* n. sp. として記載した。

和泉山脈産の *Y. obsoleta* は、九州の下甕島や天草下島の姫浦層群産のものよりはやや大型で、肋の弱化がやや進んでいるように見受けられる。また、*Y. tanii* は、その幼期において *Y. obsoleta* とよく似た装飾を持つものの、成殻では弱く数少ない不完全な亜同心円肋で特徴づけられ、他に類例のない形態をしている。

なお、日本産既知種の *Yaadia* に含められるべき三角貝についても言及した。

Introduction

The “knobby trigonians” are rather rare from the Upper Cretaceous Izumi Group in Southwest Japan. Three species have hitherto been described from that in Shikoku based on only a few poorly preserved specimens (YEHARA, 1923a・b; KOBAYASHI and AMANO, 1955; NAKANO, 1958).

Recently many specimens were obtained from the Izumi Mountains by enthusiastic hunters of fossils in this province. We, in co-authorship with them, reported the occurrence of these trigonians and discussed its stratigraphic significance, illustrating some of them without description (MOROZUMI *et al.*, 1981). This paper is to describe paleontologically these trigonians from the Izumi Mountains with some other subsequent collections.

The Late Cretaceous knobby trigonians of Japan have been classified in *Steinmanella* since KOBAYASHI and AMANO (1955). We, however, intend to accept *Yaadia* as a generic

* Contributions from the Osaka Museum of Natural History, No. 260 (Received May 15, 1982)

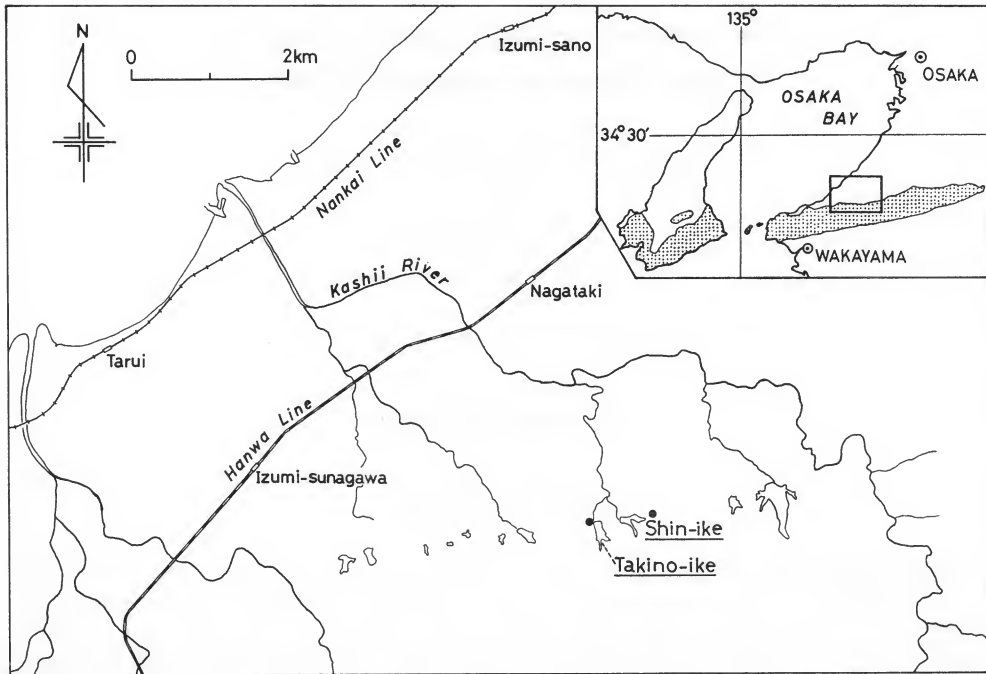


Fig. 1. Map showing the localities of *Yaardia* (with solid black circles) in the Izumi Mountains. Dotted area in the index map indicates the distribution of the Izumi Group.

name for them in the description below, as SAUL (1978) did. Some comments on Japanese *Yaardia* are also given.

Before going further, we express our sincere thanks to Mrs. Motohiro KUWANO, Masanori TANI, Jun-ichi MIYAMOTO and Katsukichi YAMAMOTO for their kindness of supplying us their collections.

Systematic Description

Family Trigoniidae LAMARCK, 1819

Subfamily Myophorellinae KOBAYASHI, 1954

Genus *Yaardia* CRICKMAY, 1930

Type-species.—*Yaardia lewisagassizi* CRICKMAY, 1930: Cascade Bay, British Columbia; Middle Valanginian?

Remarks.—*Yaardia* was originally erected by CRICKMAY (1930). It has, however, generally been ignored or marginally commented upon by many workers of Trigoniidae, excluding COX (1952; 1969), because of the poor preservation of the holotype and the brief original description.

Recently, SAUL (1978) redefined *Yaadia* based on her phylogenetic and paleobiogeographical studies of North American materials. She also discriminated *Yaadia* from *Steinmanella* CRICKMAY, 1930 as a distinct genus, because of the difference of ornamentations in the area, and aligned *Yeharella* KOBAYASHI and AMANO, 1955 described as a subgenus of *Steinmanella* with *Yaadia*, because of the same features of lacking transverse costellae on the area. We agree with SAUL (1978) in regarding *Yeharella* as a synonym of *Yaadia*.

The anterior angulation defined by SAUL (1978), which appears on the anterior marginal part being accompanied with a row of large nodes, is one of the characteristics of this genus. But, as has been discussed by SAUL (1978), it becomes obscure or fades away in the species of Late Turonian and younger age. The anterior angulation is certainly absent in Hetonaian (Campanian—Maastrichtian) species of Japanese *Yaadia*, e. g. *Y. japonica*, *Y. obsoleta* and *Y. tanii*, whereas it is discernible in *Y. ainuana* from the Gylakian (Cenomanian—Turonian) and *Y. kimurai* s. str. from the Lower Urakawan (Coniacian), distinctly in the former but indistinctly in the latter. A smooth narrow lunular area noticed by TASHIRO (1978), which develops on the antero-dorsal part of the species of younger age, may be deputized for the anterior angulation.

List of Japanese Yaadia.—

1. *Trigonia japonica* YEHARA, 1923: Izumi Group in Shikoku, Himenoura Group in Amakusa and Koshiki Islands of Kyushu; Lower Hetonaian (Middle and Upper Campanian)
..... *Yaadia japonica* (YEHARA)
2. *Trigonia kimurai* TOKUNAGA and SHIMIZU, 1926: Futaba Group in Central Japan, Uwa-jima Group in Shikoku (a specimen collected by Mr. I. MIZUNO; *non* KOBAYASHI and AMANO, 1955, pl. 13, figs. 1, 2 from the Izumi Group in Shikoku); Lower Urakawan (Coniacian)
..... *Yaadia kimurai* (TOKUNAGA and SHIMIZU)
3. *Trigonia ainuana* YABE and NAGAO, 1928: Middle Yezo Group in Hokkaido; Gylakian (Cenomanian—Turonian) *Yaadia ainuana* (YABE and NAGAO)
4. *Trigonia deckeina* KUBOTA, 1952: Hakobuchi Group in Hokkaido; Hetonaian (Campanian or Maastrichtian)? *Yaadia deckeina* (KUBOTA)
5. *Steinmanella (Yeharella) lymani* KOBAYASHI and AMANO, 1955: Middle Yezo Group in Hokkaido; Gylakian (Cenomanian—Turonian)
..... *Yaadia lymani* (KOBAYASHI and AMANO)
6. *Steinmanella (Yeharella) japonica* var. *obsoleta* KOBAYASHI and AMANO, 1955: Himenoura Group in Amakura and Koshiki Islands, Izumi Group in Izumi Mountains; Hetonaian (Uppermost Campanian—Maastrichtian)
..... *Yaadia obsoleta* (KOBAYASHI and AMANO)
7. *Steinmanella (Setotrigonia) shinoharai* KOBAYASHI and AMANO, 1955: Izumi Group in Shikoku; Lower Hetonaian (Upper Campanian)
.....? *Yaadia shinoharai* (KOBAYASHI and AMANO)

8. *Yaadia tanii* TASHIRO and MOROZUMI, n. sp.: Izumi Group in Izumi Mountains; Upper Hetonaian (Maastrichtian)

We remove *Steinmanella* (*Yeharella*) *jimboi* KOBAYASHI and AMANO (1955, p. 204, pl. 13, fig. 4) from the Middle Yezo Group in Hokkaido from the list above, because it remind us a possibility to be a species in *Litschkovitrigonia* as has been pointed out by SAUL (1978, p. 13). We also do so *S. (Y.) kimurai sanukiensis* NAKANO, 1958 [= *S. (Y.) kimurai*: KOBAYASHI and AMANO, 1955, pl. 13, fig. 2], as it lacks the anterior angulation but is characterized by a smooth narrow lunular area. *S. (Y.) kimurai sanukiensis* may possibly be conspecific with *Yaadia japonica*, when considered together that it occurred in the Izumi Group in Shikoku (Upper Campanian).

Yaadia obsoleta (KOBAYASHI and AMANO)

Pl. 1, Fig. 1; Pl. 2, Figs. 1-2

1955. *Steinmanella* (*Yeharella*) *japonica* var. *obsoleta* KOBAYASHI and AMANO, *Japan. Jour. Geol. Geogr.* 27(3-4), p. 202, pl. 14, figs. 4-5.
 1976. *Steinmanella* (*Yeharella*) *japonica obsoleta* KOBAYASHI and AMANO: TASHIRO, *Palaeont. Soc. Japan, Spec. Papers* (19), p. 58, pl. 7, figs. 18-21.
 1978. *Steinmanella* (*Yeharella*) *japonica obsoleta* KOBAYASHI and AMANO: TASHIRO, *Res. Rep. Kochi Univ.* 27 (*Nat. Sci.*), p. 138, pl. 1, figs. 1-5; text-fig. 2A.
 1981. *Steinmanella* (*Yeharella*) *japonica obsoleta* KOBAYASHI and AMANO: MOROZUMI, KUWANO, TANI, MIYAMOTO and TASHIRO, *Bull. Osaka Mus. Nat. Hist.* (34), pl. 1, figs. 1-3; pl. 2, figs. 1-3.

Material.—MK536, left valve and MT332, right valve, from Takino-ike; MK634 and JM166, left valves, from Shin-ike; MK635 and MK636, right valves, from Shin-ike; JM309 and KSG4001 (coll. by K. YAMAMOTO and donated to Kochi University), conjoined valves, from Shin-ike. MK, MT and JM indicate the M. KUWANO's, M. TANI's and J. MIYAMOTO's private collections, respectively. The specimens from the Himenoura Group, treated by TASHIRO (1976; 1978), were also examined for comparison.

Description.—(see TASHIRO, 1978)

Measurements.—

Specimen	Length(mm)	Height(mm)	Thickness(mm)
MK635, right valve	57.5+	53.5+	—
MT332, right valve	72.6+	58.8+	27.9
MK536, left valve	61.4	59.2	—
JM166, left valve	94.1	63.9	31.2
JM309, conjoined valves	89.2+	81.0	54.5/2
KSG4001, conjoined valves	99.5	85.5	27.5 (r. v.)

Remarks.—The specimens from the Izumi Group are somewhat larger in size than those

from the Himenoura Group in Kyushu. They are, however, undoubtedly conspecific with the typical examples of this species from the Koshiki Islands (KOBAYASHI and AMANO, 1955, pl. 14, figs. 4, 5), in having the same features defined by one of us (TASHIRO, 1978), except for the difference in size. This species is changeable in the outline through the growth. The younger specimen is generally characterized by a roundly subtrigonal outline, whereas the mature one shows a roundly subquadrate outline. The subdiagonal costae on the disk are also variable in the strength, but are rather uniform in number with about 11.

This species was originally founded by KOBAYASHI and AMANO (1955) as a variety of *Steinmanella* (*Yeharella*) *japonica* (YEHARA) (= *Trigonia japonica* YEHARA, 1923). Although HAYAMI (1975) synonymized this variety with *S. (Y.) japonica*, TASHIRO (1976; 1978) ranked it up to a subspecies, as *S. (Y.) japonica obsoleta* KOBAYASHI and AMANO. We, in this paper, treat it as a distinct species, i.e. *Yaadia obsoleta* (KOBAYASHI and AMANO), as has already been suggested by TASHIRO (1978).

This species is closely allied to, but is clearly discriminated from *Y. japonica* in its less developed tuberculations on the marginal and dorsal carinae and median carina of the area.

Occurrence.—Grey sandy siltstone, near the base of the Azenotani Formation at Takino-ike and Shin-ike, Izumi-sano City, Osaka Prefecture. The Azenotani Formation is now defined as a muddy, northern marginal facies above the basal conglomerate of the Izumi Group in the Izumi Mountains (ICHIKAWA *et al.*, 1979), probably representing a neritic shelf facies. The stratigraphic positions of the fossil localities in the Azenotani Formation are shown in MATSUMOTO and MOROZUMI (1980, p. 3, table 1).

The trigonians are associated with such ammonites as *Nostoceras* aff. *hetonaiense* MATSUMOTO, *Hypophylloceras* (*Neophylloceras*) cf. *hetonaiense* (MATSUMOTO), etc. (see MATSUMOTO and MOROZUMI, 1980), which remind us Maastrichtian age, as well as some other molluscs of Maastrichtian aspect.

Distribution.—This species is hitherto known from several localities of Southwest Japan, i.e. Nakakoshiki Island (type locality, from U-IV Formation of the Upper Himenoura Subgroup: Maastrichtian), Shimokoshiki Island and Amakusa-Shimo-jima (member U-IIIa of the same subgroup: Uppermost Campanian or ? Maastrichtian) and Izumi Mountains (Azenotani Formation of the Izumi Group: probable Maastrichtian). This species probably ranges from the Uppermost Campanian to the Maastrichtian, whereas *Yaadia japonica* is restricted in the Middle and the Upper Campanian in Shikoku and Kyushu. It seems that *Y. obsoleta* is probably one of the derivations from *Y. japonica*.

Yaadia tani n. sp.

Pl. 3, Fig. 1

1981. *Steinmanella* sp.: MOROZUMI, KUWANO, TANI, MIYAMOTO and TASHIRO, *Bull. Osaka Mus. Nat. Hist.* (34), pl. 2, fig. 4.

Material.—Holotype, OMNH. M2187 (=MT377, collected by M. TANI and donated to the Osaka Museum of Natural History), right valve, from Takino-ike.

Description.—Shell large for trigonians but medium for *Yaadia*, roundly ovate in outline, longer than high, moderately inflated; umbo more or less prominent, weakly opisthogyrate, located at about a fifth from front of the valve; anterior margin arched moderately and gradually changing into broadly arched ventral margin; siphonal margin weakly convex, elongated with about a half of valve height; dorsal margin very weakly convex but somewhat concaved near the umbonal part; disk broad, ornamented with two sorts of costae; subdiagonal costae low but broad, irregularly nodulated or tuberculated, appear on the umbonal region with about 6 in number; the other sort of costae subhorizontal, round-topped, low but distinct, narrower than their interspaces, appear on the anterior half of the disk, number about 10, gradually effaced towards the ventral margin; two or more subhorizontal costae near the umbo connected with diagonal costae, and the other ones curved down near the anterior margin; posterior half of the disk nearly smooth except for growth lines, but sometimes ornamented by several weak horizontal broken costae, which are discrepantly arranged from the subhorizontal costae on the anterior half; area smooth only for growth lines; median groove of the area indistinct; escutcheon very narrow, lanceolated, more or less depressed on the anterior half than the posterior half, nearly smooth except for fine growth lines; posterior carina indistinct, but observable as a roundly swollen carinal ridge which extends straightly from the umbo to the posterior end of the ventral margin; escutcheonal carina indistinct except for that near umbonal region; a smooth lunular area narrowly located along the anterior margin near the umbo.

Observation.—The holotype, 93.6 mm long, 79.9 mm high and 22.0 mm thick, is a well preserved right valve. The anterior angulation is indistinct in this species. The test of the valve is thick for trigonians, but is not so thick as that of *Yaadia obsoleta*. The subdiagonal costae, remaining distinctly on the umbonal region, are soon replaced by the subhorizontal ones on the main part of the disk. But, the curved parts of subhorizontal costae near the anterior margin may be possible traces of subdiagonal ones.

Comparison.—Although the younger stage of this species is similar to that of *Yaadia obsoleta* (KOBAYASHI and AMANO) in its subdiagonal costae and narrow escutcheon, the mature stage is clearly discriminated from the latter in its more smooth escutcheon, less developed subdiagonal costae on the main part of the disk, almost smooth surface of the posterior half of the disk, less elevated posterior carina and less inflated valve.

The holotype of this species seems to have some resemblance to *Steinmanella* (*Setotrigonia*) *sinoharai* KOBAYASHI and AMANO (1955, p. 207, pl. 15, figs. 1-3) (= ? *Yaadia sinoharai*) from the Izumi Group in Shikoku in its subhorizontal or subconcentric costae on the disk, to which we, however, have a query. Although this is not the place to discuss about *S. (S.) sinoharai*, we would like to make some comments on it. As the holotype of *S. (S.) sinoharai* is undoubtedly an external mould of a right valve, which was mistaken to be a left

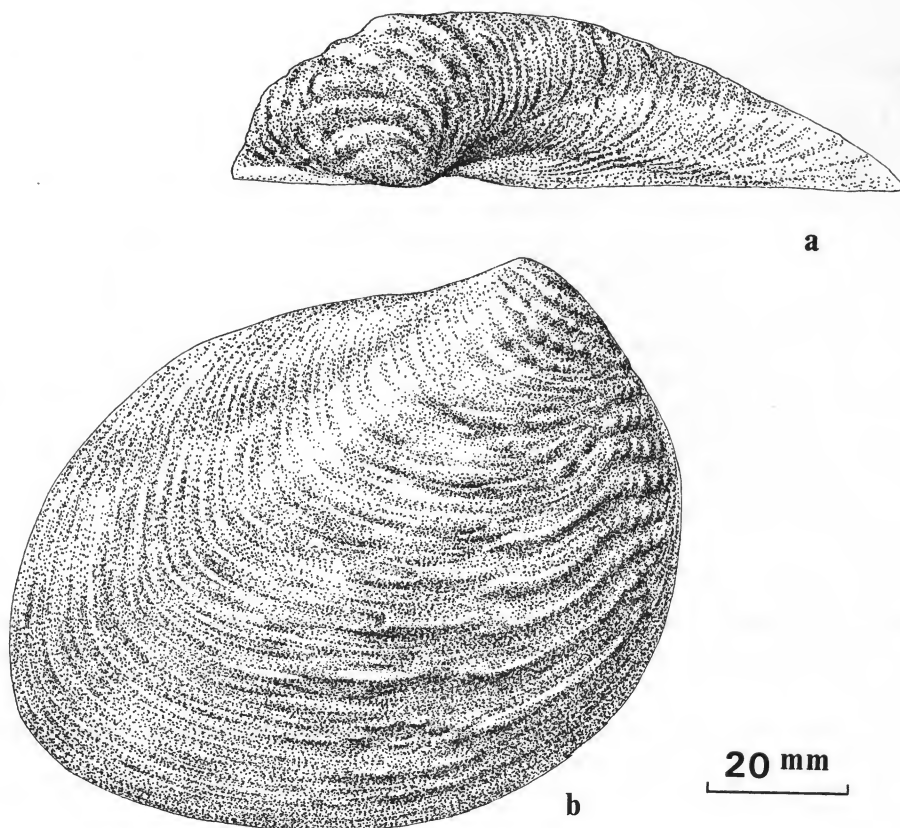


Fig. 2. *Yaadia tanii* n. sp.

Dorsal (a) and lateral (b) views, illustrations based on the holotype (M.T. delin.).

valve by KOBAYASHI and AMANO (1955, p. 207), posterior (*non* anterior) half of the shell is broken off. Consequently, the sculpture of the area can not be observable. If the holotype is complete, the costae seem not to be so subconcentric, but may be rather subdiagonal. Generally speaking, it is frequent that the costae look like rows of long strips instead of rows of nodes, when sandy matrix firmly attached on the surface of the shell is not clearly taken off. "Subconcentric costae" of *S. (S.) sinoharai* may be such a case. *S. (S.) sinoharai* seems for us not to be so different from *Yaadia japonica* (YEHARA), although we must obtain and examine some more materials as well as the type specimens to get a conclusion.

So far as we know, no species which resembles this species has been described from the Cretaceous of outside Japan, even in North America (ref. ANDERSON, 1958; SAUL, 1978).

Occurrence.—Sandy siltstone of the Azenotani Formation at Takino-ike, Izumi-sano City, Osaka Prefecture; probable Upper Hetonaian (Maastrichtian).

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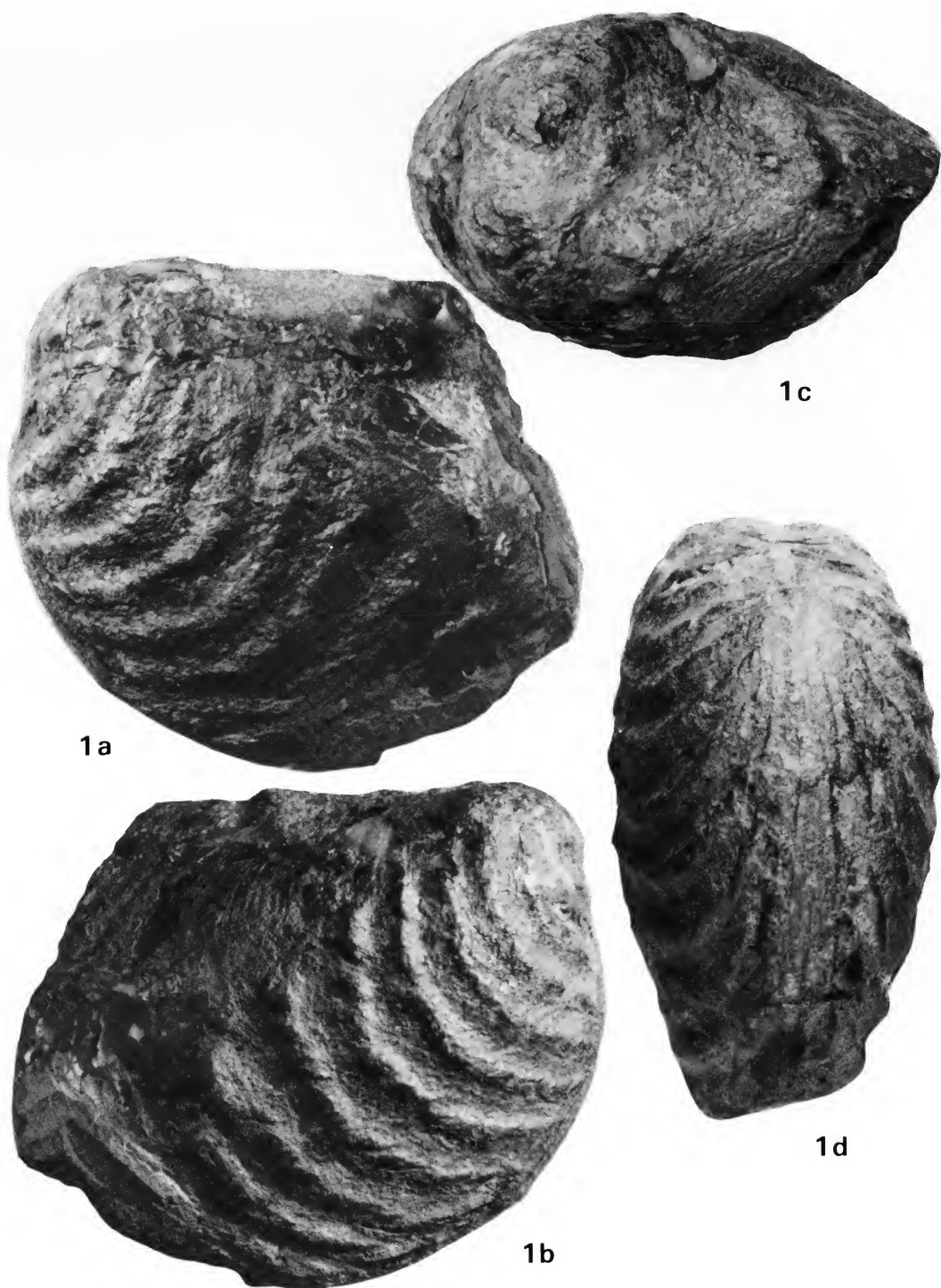
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Explanation of Plate 1

Fig. 1. *Yaadia obsoleta* (KOBAYASHI and AMANO)

JM309 (J. MIYAMOTO's Coll.), conjoined valves, from Shin-ike.

Two lateral (a, b), dorsal (c) and anterior ventral (d) views, $\times 1$.



Explanation of Plate 2

Figs. 1-2. *Yaardia obsoleta* (KOBAYASHI and AMANO)

1. Left lateral view of conjoined valves, KSG4001(coll. by K. YAMAMOTO), from Shin-ike, $\times 1$.
2. Lateral (a) and dorrsal (b) views of left valve, JM166 (J. MIYAMOTO's Coll.), from Shin-ike, $\times 1$.

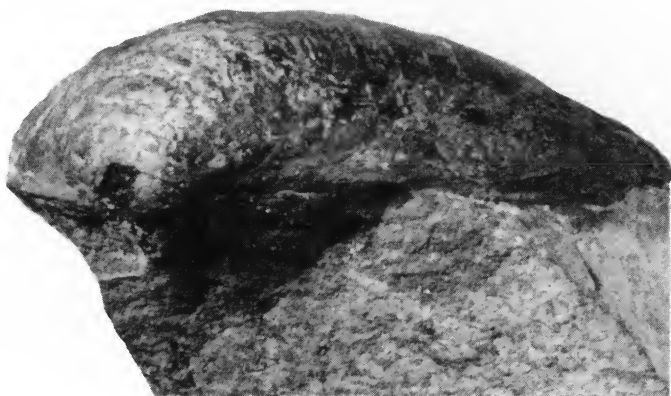


Explanation of Plate 3

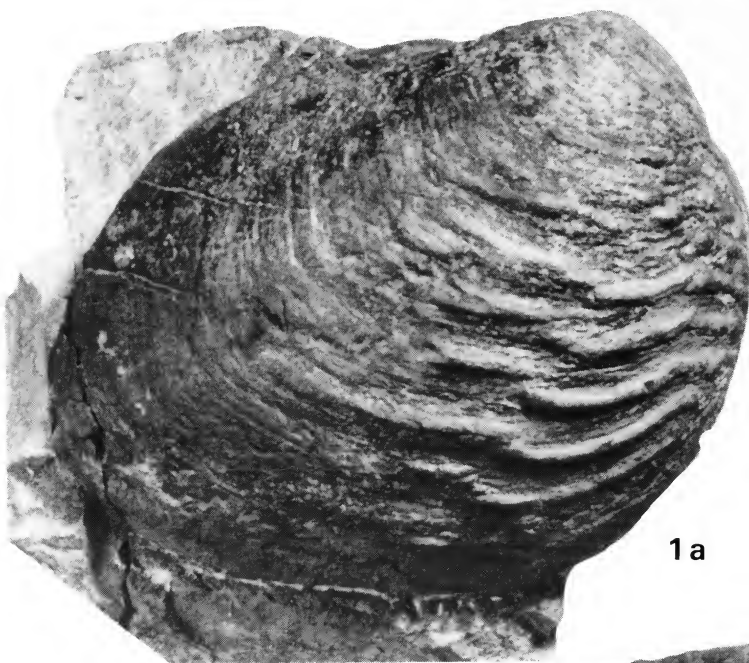
Fig. 1. *Yaadia tanii* n. sp.

OMNH. M2187(coll. by M. TANI), holotype, right valve, from Takino-ike.

Lateral (a), dorsal (b) and anterior (c) views, $\times 1$.



1b



1a



1c